HYDROCARBON POTENTIAL OF THE WESTERN NEWFOUNDLAND ONSHORE AREA

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Top Photograph: Dolomitized Boat Harbour Formation (St. George Group) exhibiting vuggy porosity.

Center Photograph: The base of the Table Point Formation (Table Head Group) overlying buff coloured dolostones of the Aguathuna Formation (St. George Group).

Bottom Photograph: Dipping oil from an unidentified, abandoned well at Shoal Point, Port au Port Peninsula (mid 1950's).

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This report has been prepared by the Petroleum Resources Branch of the Newfoundland and Labrador Department of Energy to provide additional information on the oil and gas potential of the west coast of the island of Newfoundland. It is intended to serve as a supplement to the 1982 report issued by the Petroleum Directorate[1] entitled "ONSHORE/OFFSHORE WESTERN NEWFOUNDLAND: PROSPECTS FOR PETROLEUM". Although no hydrocarbon exploration has occurred in this area since that publication, some significant new research has been conducted. This report presents a revised overview of the geology from a petroleum perspective and summarizes the recent research in this area that would be of interest to the oil and gas industry.

[1] *On April 1, 1987, the Department of Energy was established and includes what was formerly called the Petroleum Directorate.*

The presence of hydrocarbons within the Humber Zone of western Newfoundland was recognized as early as 1812 from the numerous occurrences of oil and gas seeps, bituminous residues and oil shales. The first well was drilled in 1867 and since then a total of 60 wells have been drilled. Most of these wells are fairly shallow (less than 700 metres) and only two exceeded 1000 metres. Although none of the wells were drilled with the benefit of geophysical data and very few were drilled with any geological control, more than half of them encountered some form of hydrocarbon. Some minor production was achieved in the early 1900s.

The Humber Zone, comprising an area of approximately 30,000 square kilometres, remains virtually unexplored. A systematic exploration program utilizing modern exploratory techniques is warranted in this area and could potentially lead to the discovery of commercial accumulations of hydrocarbons.

The evolution of the Appalachian-Caledonian Orogen involved the opening and closing of the Late Precambrian - Early Paleozoic Iapetus Ocean (Proto-Atlantic). Prior to the Mesozioc opening of the present day Atlantic Ocean, the Appalachian-Caledonian Orogen formed a continuous mountain chain that extended from East Greenland and the Scandinavian Caledonides in the north to the North American Appalachians and the West African Mauritanides in the south (Williams, 1986) (Figure 1).

The island of Newfoundland contains a well exposed portion of the Appalachian-Caledonian fold belt and has been divided into four zones based on lithologic and tectonic character (Williams, 1979) (Figure 2). These are:

(1) *The Avalon Zone:* Late Precambrian volcanics and sediments are overlain by Cambrian and Ordovician strata. These relatively undeformed Paleozoic rocks have correlatives on the eastern side of the present Atlantic and yield abundant fossils of European (Acado-Baltic) affinity.

(2) *The Gander Zone:* Mainly pre-Middle and Middle Ordovician metamorphosed arenaceous rocks.

(3) *The Dunnage Zone:* Dominantly mafic volcanics and associated marine sediments which overlie an ophiolitic sequence. This zone is interpreted to represent vestiges of the Iapetus Ocean.

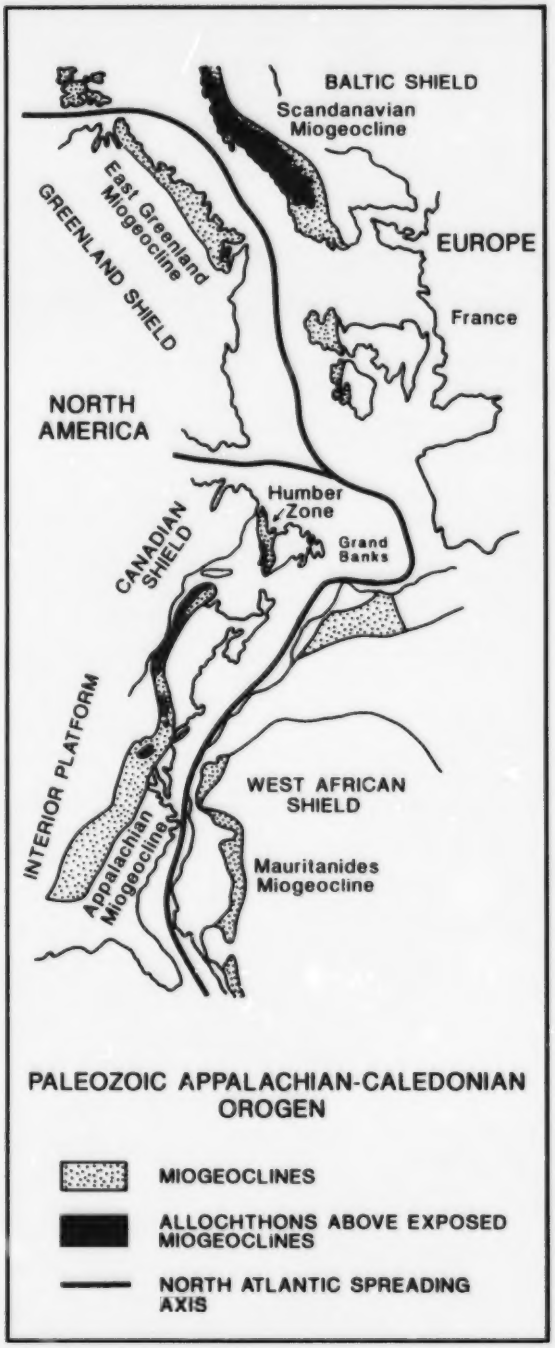

Figure 1. *Miogeoclines of the restored North Atlantic region (modified from Williams, 1984).*

(4) *The Humber Zone:* Grenvillian basement is in part overlain by a shallow water platformal sequence and a deeper water succession.

Of these four zones, only the Humber zone and its offshore extension are recognized as having significant hydrocarbon potential. This report will focus on the onshore portion of this zone.

The Humber Zone consists of five distinct lithological associations (Figure 3):

(1) A Precambrian crystalline basement (the Long Range Mountains).

(2) A Cambro-Ordovician autochthonous (non-transported) succession of shallow water sedimentary rocks (Labrador, Port au Port, St. George and Table Head Groups, and Mainland Sandstone and Goose Tickle Formation).

(3) A Cambro-Ordovician allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks (Curling Group, Cow Head Group, Lower Head Formation, Maiden Point Formation and Ophiolite Complexes).

(4) A localized upper Middle Ordovician and Silurian to Devonian neoautochthonous (non-transported) succession of clastics and carbonates resting unconformably on the allochthon and locally on the autochthon (Clam Bank Group and Long Point Group).

(5) Carboniferous clastics occurring in two separate basins (the Deer Lake Basin and the Bay St. George Subbasin).

The Cambro-Ordovician rocks rarely exceed 2 km in thickness throughout the autochthon, but slices within the Humber Arm and Hare Bay allochthons represent up to 10 kilometres of sampled lithosphere (James and Stevens, 1986). These sediments are remnants of the Paleozoic continental margin of eastern North America that bordered the Iapetus Ocean. Figure 4 illustrates the

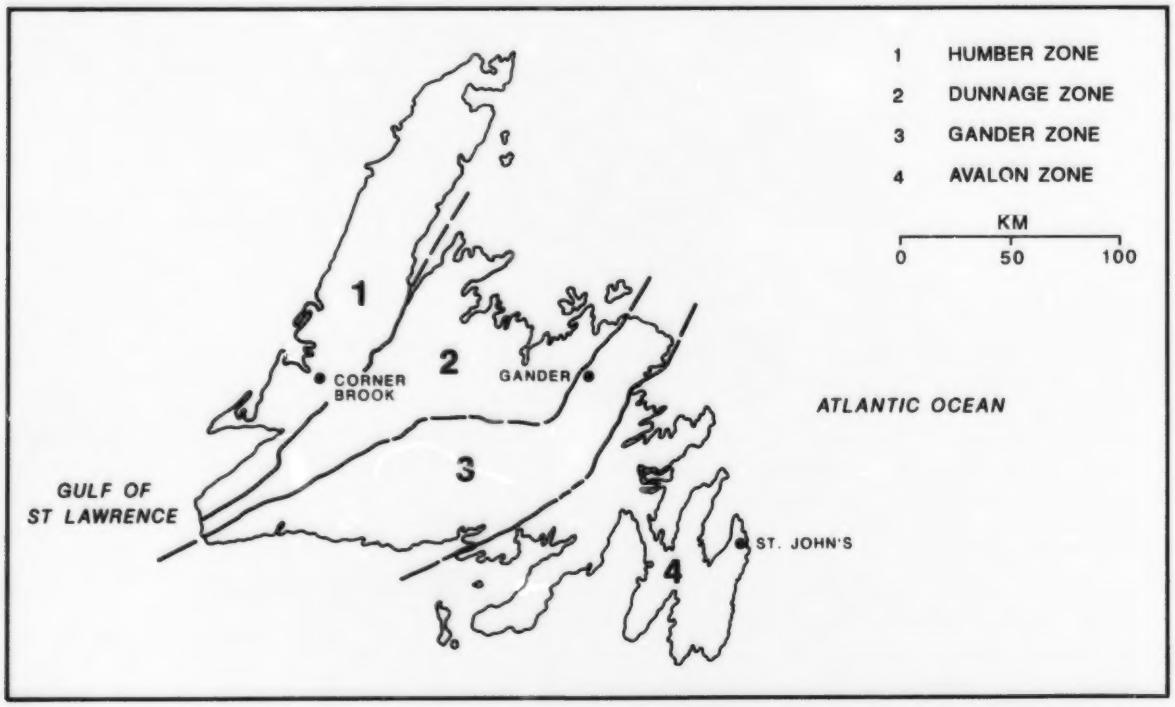

Figure 2. *Tectonostratigraphic zones in Newfoundland (after Williams, 1979).*

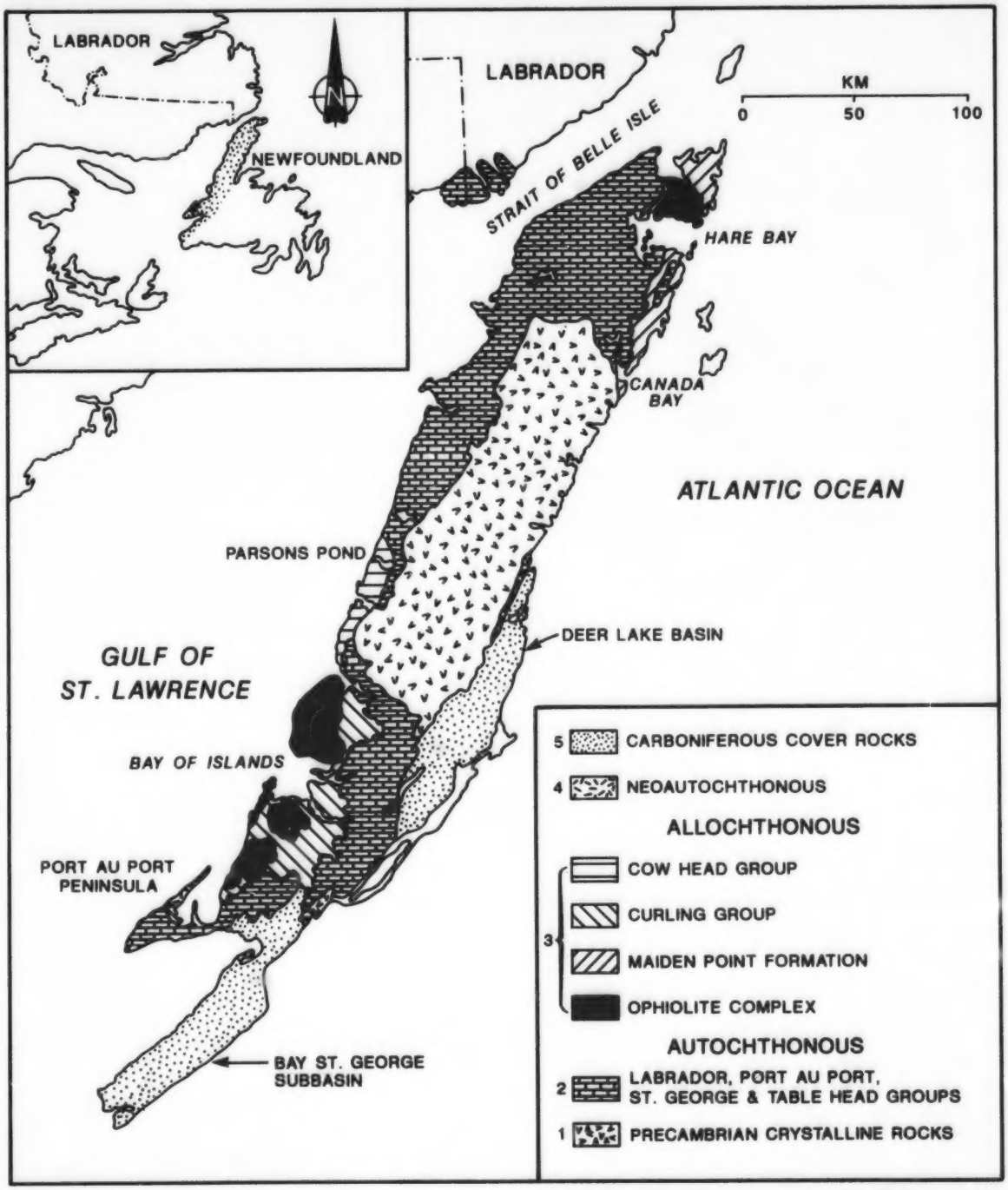

Figure 3. *Geological map of Humber Zone in western Newfoundland (after James and Stevens, 1986).*

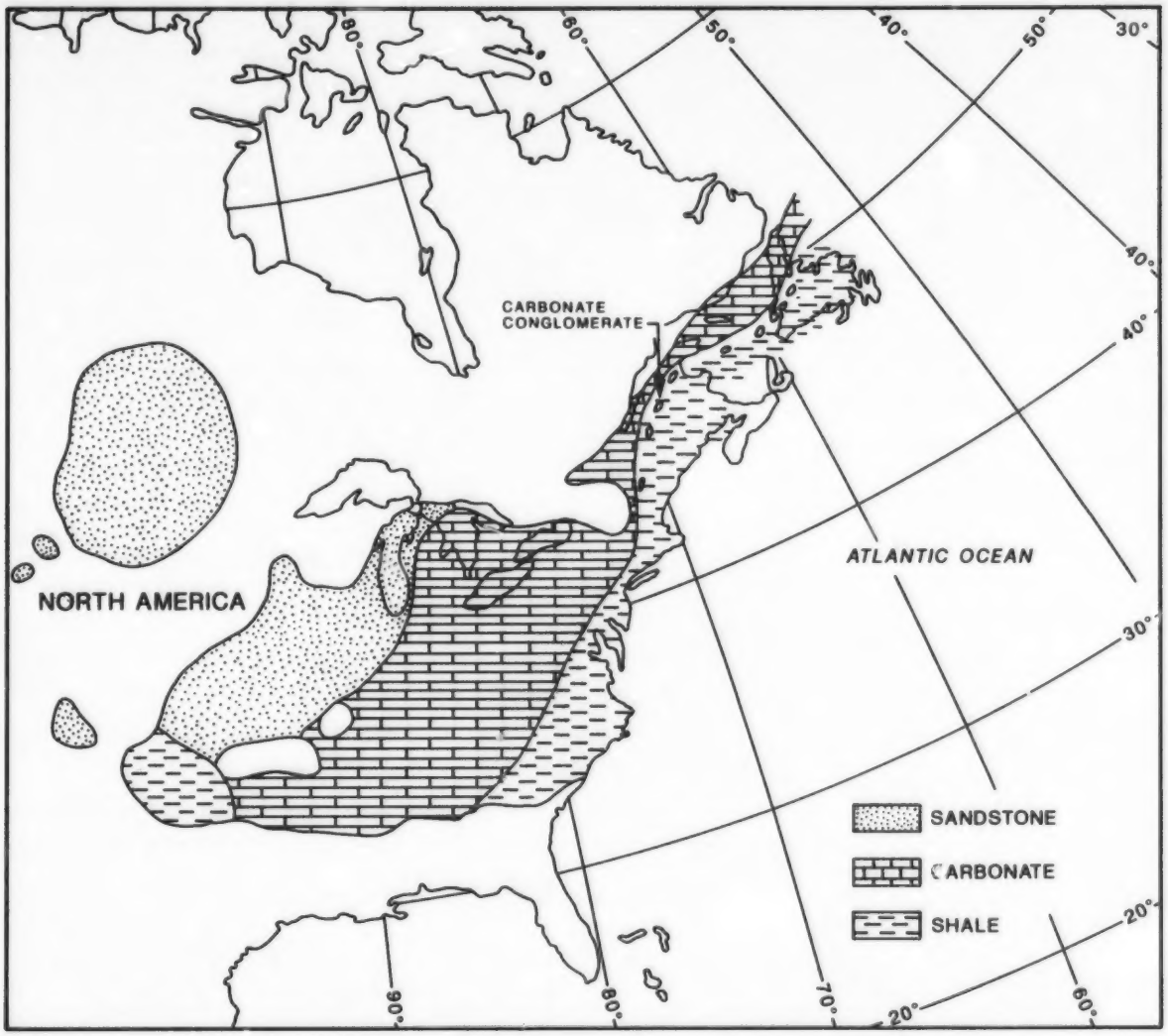

Figure 4. *Early Middle Ordovician sedimentary facies covering the eastern margin of ancient North America (modified after Dott and Batten, 1971).*

geographic distribution of the sedimentary facies of this ancient continental margin. The outer platform is preserved as a slightly deformed, mainly carbonate, autochthonous sequence. The slope to basin elements are preserved as allochthonous sediments that were thrust westward onto the autochthonous shelf sediments during the Middle Ordovician Taconian Orogeny.

Carboniferous sediments, the youngest present in the Humber Zone, are believed to have accumulated within a large area of subsidence that extended from the Bay of Fundy to northern Newfoundland. Carboniferous rocks occur in two basins (Figure 3), the Deer Lake Basin and the Bay St. George Subbasin, and contain sediments which range in thickness from 1700 to 10,000 metres (Hyde, 1979; Knight, 1983).

Tectonic History Although the Humber Zone is known to have been affected by three orogenic events, deformation tends to be either localized or to have resulted in the creation of broad open folds.

The first orogenic event, the Taconic Orogeny of late Middle Ordovician age, resulted in the thrusting of the slope to basin rocks westward onto the shelf carbonates. This is believed to have had only minor effects on the underlying autochthonous sequence as deformation is generally confined to melange zones within the allochthonous unit.

The second major event, the Acadian Orogeny of Middle to Upper Devonian age, affected the autochthonous, allochthonous and neoautochthonous rocks. A large block of Precambrian basement was also uplifted and thrust westward over autochthonous and allochthonous rocks, producing a narrow belt of deformation along the eastern margin of the platform. This uplifted Precambrian block now forms the core of the Long Range Mountains.

The third orogenic event, referred to as the Maritime Disturbance (Alleghenian Orogeny), did not significantly affect Cambro-Ordovician strata but did produce a system of northeasterly trending faults and folds within Carboniferous rocks.

Autochthonous Rocks During the Late Precambrian, Grenvillian basement was block faulted and intruded by mafic dykes. From Late Precambrian to Middle Cambrian, a narrow shelf developed. Sedimentation consisted of westerly derived terrigenous clastics and minor carbonates of the Labrador Group in the form of an onlap-offlap sequence (Figures 5 and 6).

The Middle to Upper Cambrian was characterized by the evolution of a high-energy, relatively narrow, carbonate platform that was dominated by cyclic terrigenous clastics and carbonates (Port au Port Group).

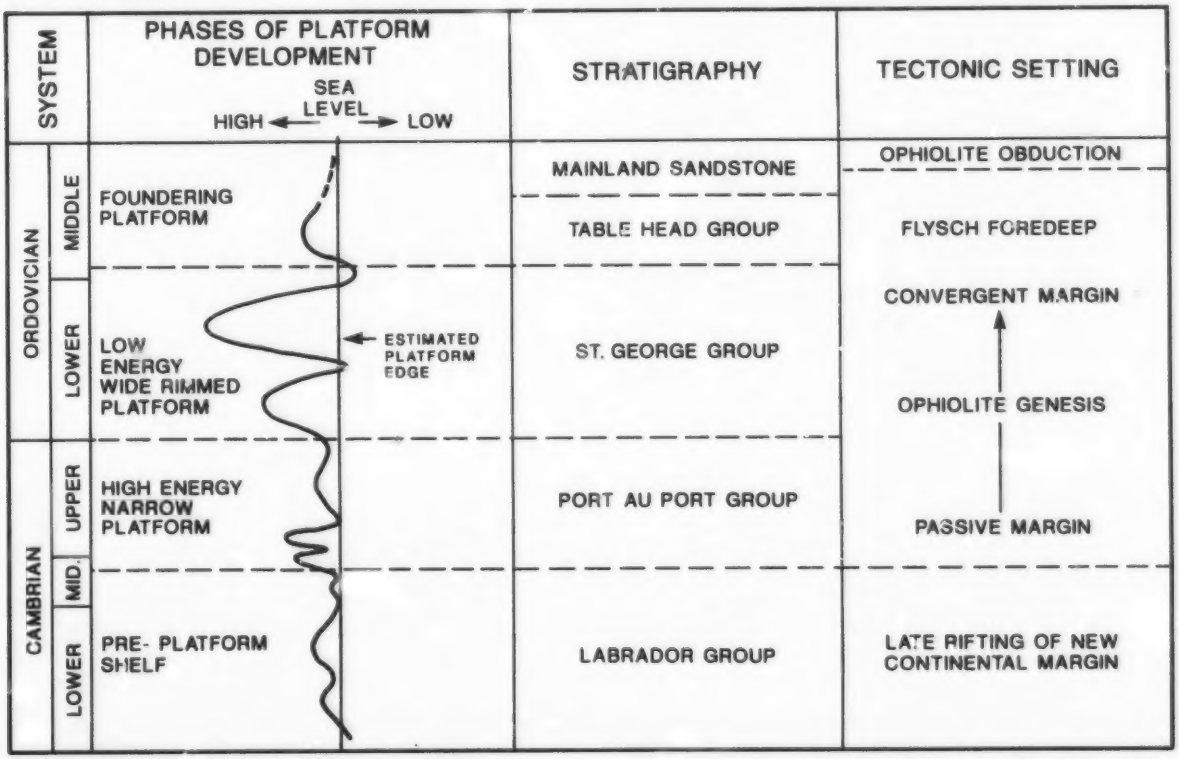

Figure 5. *The phases, stratigraphy and tectonic setting of the platform development in the Humber Zone of western Newfoundland (modified after James et al, 1988).*

Coinciding roughly with the Cambro-Ordovician boundary, the platform more than doubled in size to over 500 kilometres in width. The general style of sedimentation was one of widespread muddy and biogenic carbonate intercalated with coarse-grained storm deposits (St. George Group).

Block faulting and uplift during the Lower to Middle Ordovician resulted in widespread karstification of topographic highs. Subsequent subsidence led to the deposition of grey, thick bedded limestone and minor shale of the subtidal Table Head Group which was eventually covered by the easterly derived synorogenic flysch of the Mainland Sandstone (to the south) and the Goose Tickle Formation (to the north).

Allochthonous Rocks The next phase of platform history involved the obduction of oceanic sediment and

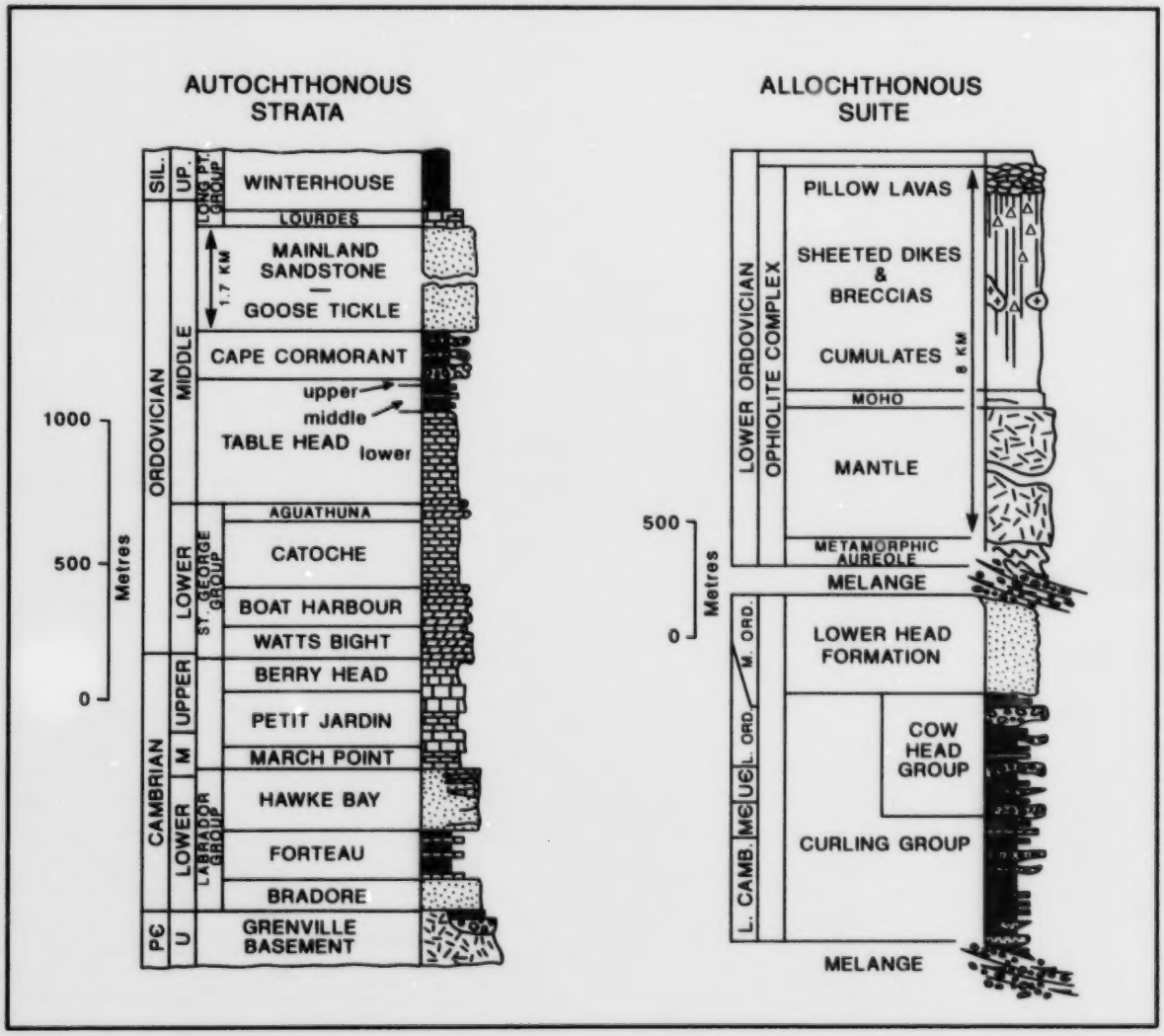

***Figure 6.** Generalized stratigraphic sections of Cambro-Ordovician autochthonous, mainly shallow water strata, and allochthonous, mainly deep water strata in western Newfoundland (James et al, 1988).*

lithosphere onto the foundered platform during the Taconic Orogeny. These tectonically transported rocks occur in a series of stacked thrust sheets within the Humber Arm Allochthon (to the south) and the Hare Bay Allochthon (to the north). The allochthon consists of a basal melange that is overlain by a series of sedimentary slices which are locally capped by ophiolitic and associated metamorphic rocks (Figure 6).

Sedimentary rocks within the Humber Arm Allochthon, sometimes referred to as the Humber Arm Supergroup, contain deepwater facies (Cow Head and Curling Groups) which are considered to be the distal equivalents of the platformal rocks (Figure 7). Lithologically, these Groups contain limestone, limestone conglomerate and shale with minor sandstone and conglomerate horizons. These deeper water equivalents of the carbonate platform are conformably overlain by synorogenic flysch (Lower Head Formation). The upper thrust slices of the allochthon contain igneous and metamorphic rocks (Skinner Cove Volcanics) and an ophiolite suite known as the Bay of Islands Complex.

The Hare Bay Allochthon, located on the northern tip of the Great Northern Peninsula, consists of deep to shallow water sediments of the Maiden Point Formation, volcanics of the Cape Onion Formation and an ophiolite suite known as the St. Anthony Complex.

Neoautochthonous Rocks A localized Middle Ordovician and Upper Silurian to Lower Devonian neoautochthonous sequence overlies both transported and non-transported rocks on the northwestern edge of the Port au Port Peninsula (see pocket map). These rocks, known respectively as the Long Point Group and the Clam Bank Group, consist of limestone, sandstone and shale.

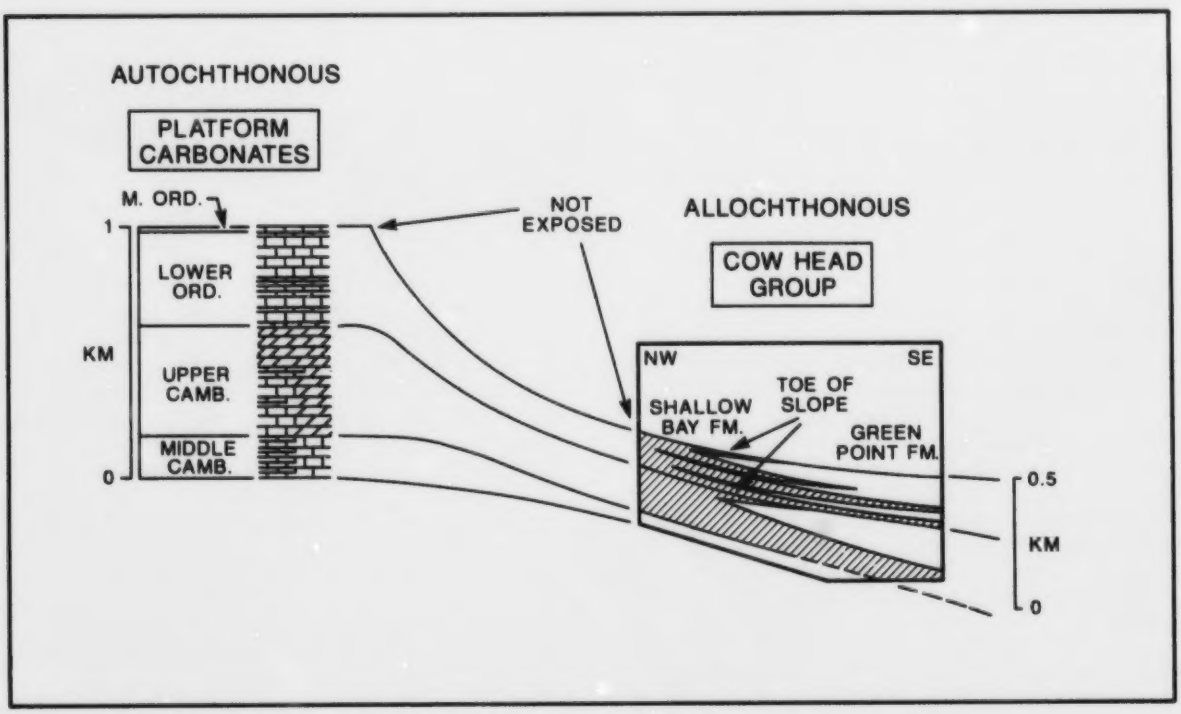

Figure 7. *A sketch illustrating the approximate disposition of the Cow Head Group and contemporaneous platform carbonates at time of deposition (James and Stevens, 1986).*

PARSONS POND AREA

Exploration History During the 100 year period from the 1860's to the 1960's, approximately 27 wells were drilled and an estimated 6000 barrels of oil were produced in the Parsons Pond - St. Pauls Inlet area. The most recent well, Nalco 65-1 (drilled in 1965), encountered shows of oil and gas and was abandoned at 1302 metres in the Lower Head Formation (see pocket map). Even though surface investigations indicate the presence of hydrocarbons in both transported and non-transported rocks, only the transported sequence has been evaluated by exploratory drilling.

Source Rocks Two separate geochemical studies have recently focused on source rock evaluation of the Cambro-Ordovician sequences. Macauley (1987a) and Weaver (thesis in preparation) sampled potential source rocks in the Parsons Pond area and analysed the samples by Rock Eval pyrolysis. Both studies concentrated mainly on the allochthonous rocks.

Macauley (1987a) found that the shales of the allochthonous Green Point Formation (Cow Head Group) are a potential source for the petroleum present in the Parsons Pond area. Rock Eval data indicate that this formation contains a type II (oil and gas prone) kerogen and has an average total organic carbon (TOC) content of 3.7% with a marginal level of thermal maturity. Other unidentified allochthonous samples and some autochthonous Table Head shales were observed to have higher levels of thermal maturity and may provide alternative sources for the Parsons Pond oil seeps.

Research results by Weaver (thesis in preparation) are generally in agreement with those of Macauley (1987a). Rock Eval data for the Green Point shales indicate a type II kerogen with an average TOC content of 1.75% and a marginal level of maturity. Rock Eval data for the underlying autochthonous rocks of the Table Head Group again suggest that they have higher levels of maturity.

Based on these results, as well as the correlation of geochemical signatures, Weaver believes that the Green Point shales are the likely source rocks for the Parsons Pond oil. Further research, concentrating on the geothermal gradients of the allochthonous rocks and the source potential of the autochthonous rocks will be required, however, to identify the definitive source of the Parsons Pond oil.

Regional Thermal History The thermal history of Cambro-Ordovician rocks in the Humber Zone has been investigated using conodont alteration indices (CAI) by Stouge (1986) and by Nowlan and Barnes (1987a, 1987b). These studies indicate that large portions of western Newfoundland, from Port au Choix in the north to Bonne Bay in the south, have experienced a thermal history that lies within the oil generation window [2] (Figure 8). CAI values of 1.5 for the allochthonous rocks in the Parsons Pond area support the marginal level of thermal maturity inferred from the Rock Eval data. To the north, at Daniels Harbour, CAI values of 2 for both allochthonous strata and autochthonous carbonates indicate a moderate level of maturity. CAI values continue to increase progressively to the north and reach a maximum in close proximity to the Hare Bay Ophiolite. Nowlan and Barnes (1987b) suggest that the high CAI values of the allochthonous strata near the ophiolites may be restricted to near surface rocks and that the underlying autochthonous strata could have lower CAI values and still be within the oil window.

The upper limit for the commercial production of gas appears to be near CAI values of 4.5 (Epstein et al, 1977; Macauley, Snowdon and Ball, 1985). CAI values exceeding this are restricted to the northern tip of the Great Northern Peninsula and the areas surrounding the Humber Arm and Hare Bay Ophiolite slices.

Reservoirs Oil production in the Parsons Pond area has historically been interpreted to have come from porous sandstones of the Lower Head Formation (Kunkle, 1986). Kunkle studied reservoir properties of the Lower Head Formation in this area using cores from two shallow drill holes (less than 20 metres deep). The cores exhibited poor to negligible porosity (average 5.5%) and very low permeability (microdarcy range). This data falls short of what was expected from the production history and Kunkle proposed that fracture enhanced permeability is required for any significant production from this formation.

On the other hand, it is noteworthy that Kunkle's interpretation of fracture porosity is based on samples

[2] *Based on the observation that oil production is limited to areas with CAI values ranging from 1.5 to 2.5-3.0, (Mitra, 1988; and Macauley, Snowdon and Ball, 1985).*

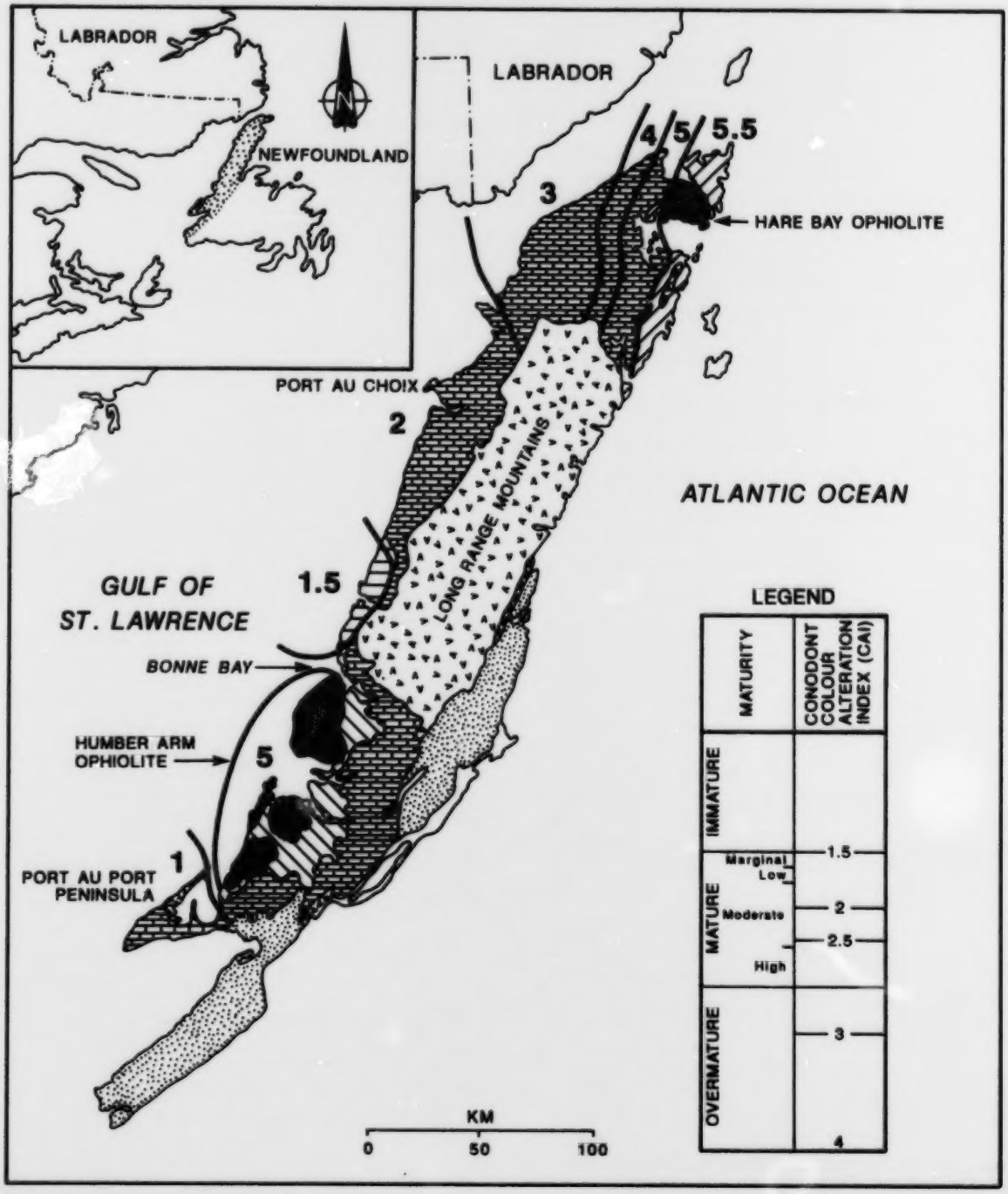

Figure 8. *Conodont colour alteration index (CAI) isotherm map for the Ordovician strata of western Newfoundland (after Stouge, 1986; Nowlan and Barnes 1987a).*

from only two shallow drill holes. Kunkle also recognizes the possibility that:

(i) the productive lithology was not recovered during coring;

(ii) coarser and cleaner intervals may exist and remain untested. This is supported by the fact that two samples from one core exhibited comparatively lower acoustic velocities implying greater porosity; and

(iii) permeabilities of these shallow samples may have been reduced by surface cementation.

Other potential allochthonous reservoirs, which remain untested, are the dolomitized, very porous Cow Head conglomerate and carbonate sands (eg. The Arches, see pocket map).

In addition to the allochthonous reservoirs mentioned above, other potential reservoirs have been identified during surface mapping of the autochthon. These include:

(i) the upper 30 to 40 metres of the Catoche Formation (St. George Group). This unit is a burrow-mottled dolomite with highly porous, bituminous beds one half to one metre thick;

(ii) the Boat Harbour Formation (St. George Group). It consists of a bioturbated dolomitic wackestone that grades upward into a dolostone and lime mudstone. Dolomitized boundstone mounds occur in several beds within this formation and exhibit good vuggy porosity (eg. top photograph on cover);

(iii) the Watts Bight Formation (St. George Group). This formation is dolomitized and exhibits a petroliferous odour.

(iv) dolomitized sections in the lower part of the Table Head Formation; and

(v) clastics of the Goose Tickle Formation and Mainland Sandstone.

None of these potential autochthonous reservoirs have been penetrated by any of the 27 wells drilled in this area and they may present attractive exploration targets.

Traps Surface mapping has defined a wide variety of trapping mechanisms including: large anticlinal structures in the autochthon, faulting and folding within the allochthon and overthrusting of the Long Range Complex over the Cambro-Ordovician sequences. Stratigraphic traps may also be provided by pinchout and facies variations.

PORT AU PORT PENINSULA

Exploration History A total of 9 wells are known to have been drilled in the Shoal Point area of the Port au Port Peninsula (see pocket map). Seven of these encountered oil and some limited production was achieved during the early 1900's. The most recent wells were drilled in 1965 for the Golden Eagle Refining Company. Shoal Point No. 1 was drilled through the allochthon and penetrated 49 metres of the autochthon. A tarry residue was encountered in the upper part of the Table Head Group. Shoal Point No. 2 was shallower and did not reach the autochthon. Oil staining was encountered and was at times heavy through much of the allochthonous sequence.

It is significant to note that hydrocarbon occurrences have been observed in all three major geological successions present on the Port Au Port Peninsula. Bitumen was found in the autochthonous limestone breccia of the Cape Cormorant Formation (Cumming, 1965). Oil production during the early 1900's came from the allochthonous strata on Shoal Point and bitumen has been observed in the shales of the neoautochthonous Long Point Formation (F. O'Brien, pers. comm.).

Source Rocks Rock Eval analysis (Macauley, 1987a) indicate TOC values of .68%, 1.11%, and 8.37%, for the Table Head Group, undifferentiated Humber Arm Supergroup and Green Point Formation shales respectively, on the Port au Port Peninsula. Rock Eval data (Macauley, 1987a) and CAI values (Nowlan and Barnes, 1987a) of surface samples from autochthonous and allochthonous strata indicate a low to marginal level of thermal maturity.

Carboniferous strata in western Newfoundland occur in two major basins and in minor localities on the east side of the Great Northern Peninsula (see pocket map). The Deer Lake Basin and the Bay St. George Subbasin are part of an extensive belt of Devonian-Carboniferous deposits termed the Maritime fold belt (Poole, 1972), which can be traced through the Maritime provinces and into the New England area.

The Deer Lake Basin and Bay St. George Subbasin, which are only 50 kilometres apart, are associated with the Cabot Fault Zone which had a history of strike slip and dip slip movements during the Carboniferous (Knight, 1983; Hyde, 1984). Sediments of the Deer Lake Basin include alluvial fan, braided and meandering river, lacustrine and coal swamp facies. The sediments in the Bay St. George Subbasin, while dominantly fluvial, also contain deltaic deposits, subtidal to intertidal carbonates and evaporites.

DEER LAKE BASIN

Exploration History A total of seven wells have been drilled in the Deer Lake Basin, the last being drilled in 1956 (see pocket map). Three of these wells encountered appreciable gas shows in the Rocky Brook and North Brook Formations of the Deer Lake Group. Although equipment was not available to measure pressures or flow rates, one of these wells was observed to be still flowing gas one year after drilling had been completed.

Stratigraphy The Deer Lake Basin is believed to contain approximately 1700 metres (Hyde, 1981) of predominantly non-marine sediment (see pocket map). These strata have been divided into four mega-sequences by Hyde (1979). Sandstones, conglomerates and minor shales of the Anguille Group, representing initial basinal fill, are overlain by sandstones, conglomerates and minor limestones of the Wetstone Point and Wigwam Brook Formations. These sequences are in part overlain by siltstones, mudstones, shales and minor conglomerates and sandstones of the Deer Lake Group. The Howley Formation, the youngest sequence in this area, is comprised of conglomerates, sandstones, shales and minor coal horizons.

Reservoirs Sandstone and conglomerate of the Humber Falls Formation (Deer Lake Group) may provide reservoirs for any hydrocarbons that have been generated from the source rocks of the Rocky Brook Formation (Deer Lake Group). Other potential reservoirs include the numerous fine grained sandstone units (up to three metres thick) which occur within the Rocky Brook Formation itself.

Structure Major longitudinal strike slip faults, associated with the Cabot Fault Zone, are a predominant feature of the Deer Lake Basin (Hyde, 1979). Fault induced folding is a pronounced feature as it is throughout the Maritime fold belt.

Folds within strata of the Deer Lake Basin can be grouped into two sets according to style and orientation. Fold set I, which occurs at oblique angles to the major faults, is confined to the Anguille Group. These folds are isoclinal and have axes that plunge at low to moderate angles. Folds of set II, which occur throughout the basin, are more open, trend parallel to faults, and tend to plunge at shallower angles than those in fold set I (see pocket map).

Traps Surface mapping has defined several trapping mechanisms that include anticlinal structures and fault traps. Traps may also be provided by pinchout and facies variation, particularly in the upper part of the Rocky Brook Formation.

Source Rocks Geochemical studies on source rock potential have, to date, been confined to the oil shales of the Rocky Brook Formation (Deer Lake Group). Rock Eval pyrolysis indicates that sediments of this formation contain a type I (oil prone) kerogen (Hyde, 1984; Macauley, 1987b).

Thermal maturation determined from vitrinite reflectance, clay mineral assemblages and illite crystallinity, indicates an average paleotemperature of 100°C for the Rocky Brook Formation (Hyde et al, 1987). This is in agreement with the low to moderate thermal maturity indicated by Rock Eval analyses (Hyde, 1984; Macauley, 1987b).

Gas shows noted in the North Brook Formation, as discussed previously, indicate the presence of older source rocks that may include:

(i) carbonaceous fine grained siltstones and black mudstones of the Anguille Group, or

(ii) black mudstones and limestones of the Wigwam Brook and Wetstone Point Formations.

Oil Shale Deposits and Mining Potential As previously mentioned, oil shales comprise an important unit in the upper part of the Rocky Brook Formation. They occur in three distinct facies associations, which are characterized by varying bed thickness and are often interbedded with other lithologies.

Hydrocarbon yields of the oil shales average 55 litres/tonne, combining figures from Hyde (1984) and Macauley (1987b), and range up to 155 litres/tonne. This is above the 42 litres/tonne, often considered a general economic cut-off. It is yet unknown, however, if these hydrocarbon yields can be sustained over sufficient thicknesses or have the areal extent required to make mining economical. The presence of thin intercalated carbonate layers may also hamper oil extraction (Hyde 1984).

On the other hand it is important to note that the current knowledge of the Rocky Brook oil shales is based on a very limited data base. Only two surface sections, isolated outcrops and a few drill holes have been studied in detail. Also, there remains a vast, largely unexplored area on the west side of the basin between Rocky Brook and the Upper Humber River. Here the Rocky Brook Formation is close to the surface with only a thin cover of Pleistocene till.

BAY ST. GEORGE SUBBASIN

Exploration History Most hydrocarbon shows in the Bay St. George Subbasin have occurred during diamond drilling operations being carried out for the evaluation of gypsum deposits in the Flat Bay area. McKillop (1957) documented a significant gas show during one such operation near Flatbay in 1956. This gas was analyzed and found to be almost entirely composed of ethane and methane.

Another drill hole in the same area recovered core from a conglomerate of the Anguille Group which was bleeding oil. Unfortunately, however, no further evaluation was conducted with regard to the hydrocarbon potential of this area.

Stratigraphy The Bay St. George Subbasin (Figure 9) contains mostly non-marine Devonian to Carboniferous sediments and is divided into three groups (Knight, 1983), each being approximately 3000 metres thick. The Anguille Group, the oldest of the three, consists of lacustrine, fluvial-deltaic and fluviatile deposits. The Codroy Group is dominated by fluviatile red beds, marine siliclastics, carbonates and evaporites. The youngest sequence, the Barachois Group, is dominated by fluvial clastics which are often coal-bearing.

Reservoirs Reservoirs within the Barachois Group include channel sandstones that exhibit poor to fair porosity. Potential reservoirs within the Codroy Group include black bituminous dolomites with intercrystalline porosity, and biochemical limestones with high inter and intra-particle porosity. The Codroy Road Formation (Codroy Group) is known to contain brachiopod buildups with very high interskeletal porosity (Knight, pers. comm.). The exposed part of such a reef observed in outcrop near Ship Cove was estimated to be 10 to 15 metres high and approximately 200 metres in width. Similar reefal buildups are known to also occur on the north shore of the Port au Port Peninsula, in the stratigraphic equivalent of the Ship Cove Formation (Knight, pers. comm.).

Structure Strata of the Bay St. George Subbasin exhibit northeasterly trending folds and faults which developed during the Late Pennsylvanian. The folds which vary from open to upright, and tight to overturned, are believed to have formed in response to strike-slip movements along the Cabot Fault Zone during the Alleghenian Orogeny.

Traps The Bay St. George Subbasin exhibits a wide variety of potential trapping mechanisms including anticlinal structures, fault traps and salt diapirs. Stratigraphic and combination traps may also exist as either pinchout and facies variations or reefal buildups.

Source Rocks Research on source rock potential has been restricted to the Barachois Group, the youngest unit in the subbasin. Organic rich facies (coal and oil shale) are present within the youngest units of the Barachois Group (Soloman, 1986). The oil shales tend to be lean, with hydrocarbon yields ranging up to 90 litres/tonne and thin (less than 0.5 metres). Kerogen is dominated by type III (gas prone) with lesser amounts of type I and type II. Thermal maturation indices are indicative of temperatures within the oil window. The presence of thermally-mature, organic-rich mudstones (up to 31.9% TOC) suggests that the Barachois Group is probably a potential gas source.

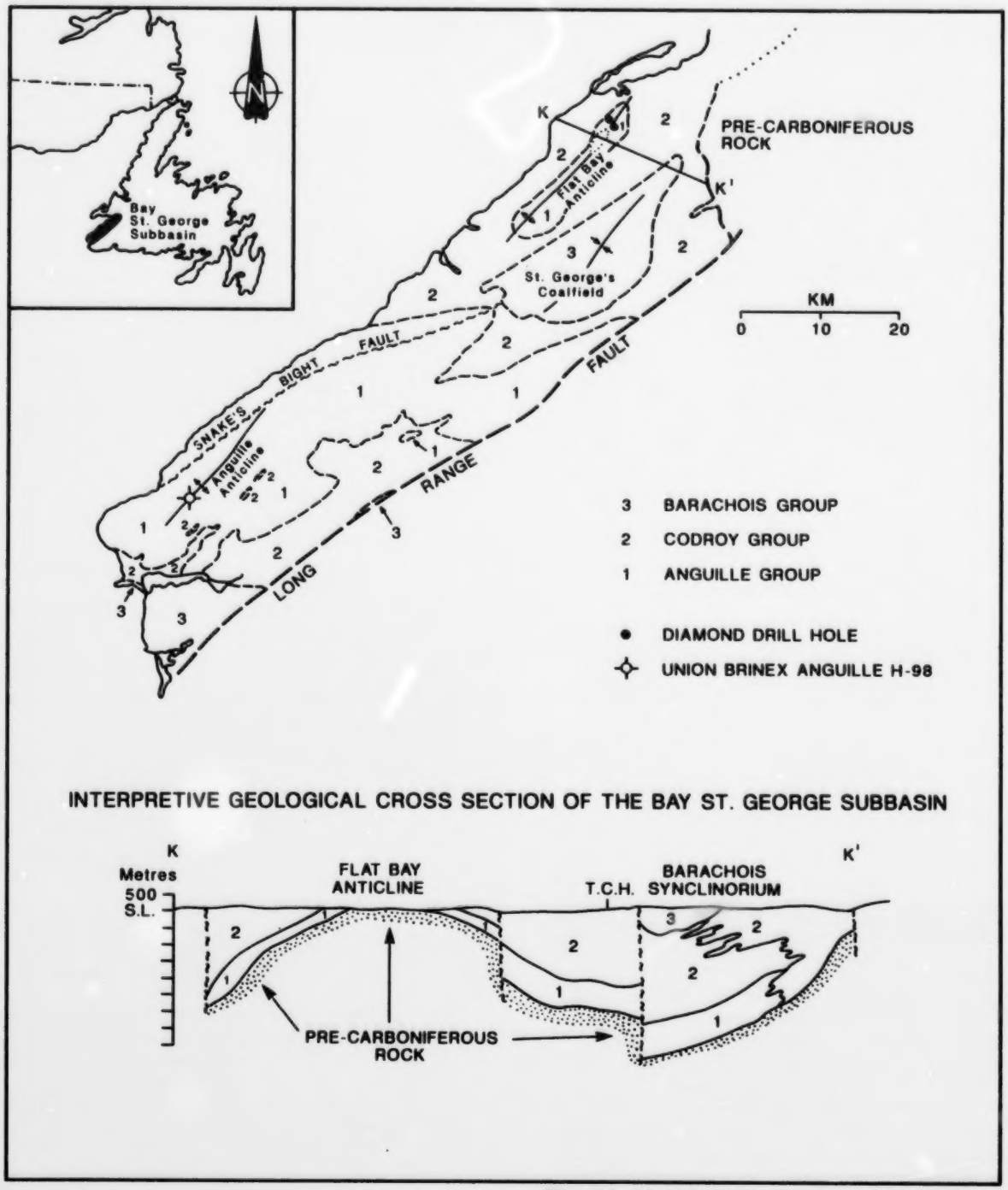

Figure 9. *Geological map and cross section of the Bay St. George Subbasin (Knight, 1983).*

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Ongoing research on the Humber Zone of western Newfoundland continues to refine our understanding of the geology and the hydrocarbon potential of the area. Surface mapping and geochemical studies have identified potential source rocks, reservoir rocks and trapping mechanisms in a number of areas. CAI studies have shown that much of the region has a thermal history within the oil window.

This research, which has been largely done on a piecemeal basis, has laid the groundwork for systematic exploration programs that will be required to assess the true potential of this area.

[redacted]

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MAPS
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